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THE NEW SESSION, 1938-39.

FURTHER STUDIES IN TROPICAL LAND TENURE.

THE IMPORTANCE AND USE OF APPROPRIATE ASSUMED MEANS IN COLLATING FIELD EXPERIMENTAL RESULTS STATISTICALLY.

PRICE 6d.

T.C.W. 1925.

Imperial College of Tropical Agriculture

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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

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THE NEW SESSION, 1938-39.

THE present session heralds exceptional changes, the most outstanding being the resignation of the Principal. Sir Geoffrey Evans' departure closes an important chapter in the history of the College which has seen many beneficial changes and much progress during his régime. Sir Geoffrey's name will be permanently associated with those who played major rôles in organising and developing our work and we can safely say that it is largely through his unremitting efforts that our future in the scheme of British Colonial development is assured. As Principal, his energy, enthusiasm and personality made him a popular leader, and all who have been associated with him will no doubt share the sentiments expressed by the Governing Body when they recorded "their high appreciation of the eminent services rendered to the Imperial College of Tropical Agriculture by Sir Geoffrey Evans, C.I.E., M.A., Principal from 1927 until his resignation, which they have accepted with great regret as from 30th September, and desire that there be conveyed to him their sincere good wishes for continued success in the post of Economic Botanist at Kew, to which he has been appointed". Sir Geoffrey's successor, Mr. Odin Tom Faulkner, to whom we extend a warm welcome, will take up his work during the middle of this month.

Another member of the senior staff to leave us is Professor Wood whose valuable services to the College as Professor of Agriculture will long be remembered. Our best wishes go with him in his retirement and we hope that he will enjoy the very best of health and much happiness in the many remaining years of active life that are still before him. We are glad to welcome in his place Professor E. Harrison whose work as Director of Agriculture in Tanganyika is well known.

As we go to press, we learn also that Mr. G. A. Jones will soon be vacating the post of Commissioner of Agriculture to become Director of Agriculture in Jamaica. By building up an efficient Advisory Department of Agriculture at the College, Mr. Jones has done much to continue the former activities of the Imperial Department of Agriculture whose functions, it will be remembered, were taken over by the College, and thus to help the cause of agriculture in the Leeward and Windward Islands. His departure will be a great loss not only to the College but also to the islands which his Department is serving. His wide experience of West Indian agricultural problems should fit him admirably for his new

appointment in which we wish him all success. Other staff changes include the promotions of Dr. A. M. Adamson, Reader in Entomology, to Professor of Entomology, and of Mr. J. G. Davies, Sugar Technologist, to Reader in Sugar Technology.

In order to enable the Department of Economics to carry out an economic survey of the systems of land tenure and types of agriculture among peasant small holders in the Leeward and Windward Islands two Survey Officers, Mr. A. H. Giuseppi and Mr. S. A. Schouten, have been appointed. The appointment of a Relief Officer to that Department has also been sanctioned to enable the Professor of Economics, who is in charge of the proposed survey, to visit the islands concerned. The staff of the Department of Sugar Technology has been strengthened by the appointment of Mr. R. D. E. Yearwood as Assistant Sugar Technologist. In the Agricultural Department, Mr. L. J. C. Evans becomes Student Demonstrator in succession to Mr. D. Hanschell, who has been appointed Assistant Botanist to the British West Indies Central Sugar-Cane Breeding Station in Barbados.

We deplore the loss through death of a member of the Governing Body, Sir Thomas Stanton, who was Chief Medical Adviser to the Colonial Office. Lieut.-Colonel Sir David Prain has been elected President of the College for life in honour of his long and loyal services to the College as Vice- and Deputy-Chairman. Three new members have joined the Governing Body: Sir Alfred Sherlock, who will represent British Guiana, Mr. Alexander Moir Reed, who has been nominated by the Leeward Islands, and Lieut.-Colonel Davson, who is Chairman of the West India Committee.

The College was represented at various important Conferences which were held during the summer months. Sir Geoffrey Evans and Mr. Jones attended the Conference of Colonial Directors of Agriculture in London, and Professor Cheesman and Dr. Wardlaw went to Berlin to attend the 12th International Horticultural Congress. Both Professor Cheesman and Dr. Wardlaw were included among those representing the Colonial Empire in the United Kingdom delegation to the Congress. Dr. Wardlaw also attended the Refrigeration Conference in London. Professor Shephard went to Canada in August to be present at the International Conference of Agricultural Economists which was held at Macdonald College. Mr. J. G. Davies is representing the College at the Sixth Conference of the International Society of Sugar-Cane Technologists in Louisiana.

The number of students at the College this session represents a record. Thirty-six are taking the Diploma course, twenty-four the Associateship course, and three, special courses. Of the Diploma students, eleven come from Trinidad, nine from the Leeward and Windward Islands, six from Barbados, four from British Guiana, four from Jamaica, one from Guatemala, and one from England. Of the Associateship students, fifteen are Colonial Office Scholars, two are Sudan Government Scholars, three are refresher scholars from West Africa, and three come respectively from Barbados, the Bahamas, and Curaçao. Of the three students taking special courses, two come from Nigeria and one from Antigua. Both Nigerian students are members of the native staff of the Nigerian Department of Agriculture and they are the first two candidates who have come to this institution under a new scheme designed to provide facilities for training selected members of the native staffs of various Colonial Departments of Agriculture. We are glad that the training facilities afforded by the College in the form of refresher courses have once again been taken advantage of by both the Nigerian and Gold Coast Governments, which have this year sent three candidates between them for these courses. We also welcome for the first time two students who have been selected under an agricultural scholarship scheme recently inaugurated by the Sudan Government and under which, we understand, further candidates will be appointed during the next five years.

The coming session promises to be exceptionally active in view of the considerable increase in our commitments as regards training, research and advisory work. For instance, a new five-year programme of research into the fundamental problems of the storage of tropical fruit and vegetables, financed from the Colonial Development Fund is now in progress, and, for this purpose, the Low Temperature Research Station has been largely reconstructed. Cacao research has also entered upon a second five-year period. The Department of Economics will soon be engaged on a survey of peasant agriculture in the Caribbean area. In short, there has generally been a progressive increase not only in our activities but also in the services rendered by all College Departments to the agricultural community.

PROFESSOR E. HARRISON, C.M.G.

Mr. E. Harrison, who succeeds Professor Wood, as Professor of Agriculture at the Imperial College of Tropical Agriculture arrived in Trinidad on 15th September. Mr. Harrison was educated at the Harris Institute, Preston, Holmes Chapel (Cheshire), at Edinburgh University where he took the B.Sc. degree in agriculture and the N.D.A., and at the State College of Agriculture and Mechanic Art, Ames, Iowa, U.S.A. Shortly after qualifying at Ames, he became County Lecturer, Midland Agricultural College, Kingston. In 1910 he went to South Africa and joined the School of Agriculture, Grootfontein, Cape, as Lecturer in Agriculture and Stock. In 1913 he became Principal of the School of Agriculture, Cedara, Natal. In 1921 he was appointed Deputy Director of Agriculture in Kenya and acted as Director of that Department in 1922, 1924, 1927 and 1928. In 1930 he became Director of Agriculture in Tanganyika Territory, a post which he held until his present appointment. He received the C.M.G. in 1935 in recognition of his work in Tanganyika.

FURTHER STUDIES IN TROPICAL LAND TENURE.

By H. M. Leake.

(*Continued from Tropical Agriculture*, Vol. XV, No. 10, p. 232.)

IV.—THE EASTERN COLONIES.

Malaya.

Malaya falls into three sections, the Straits Settlements, the Federated and the Unfederated Malay States. The first of these it is unnecessary to consider here ; they occupy some 1,356 sq. miles with a population density of 843, are almost entirely urban and include the larger towns including Singapore. Their prosperity depends on the export trade in produce raised in the hinterland and on the large entrepot trade with the Far East. Their problems are urban and not agricultural.

The Federated Malay States embrace the States of Perak, Selangor, Negri Sembilan and Pahang and are controlled by a Federal Government under a High Commissioner, the Governor of the Straits Settlements, while each State is administered under the advice of a Resident. The Unfederated States embrace Johore, Kedah, Perlis, Kelantan, Trengganu and Brunei. They differ mainly in the extent of the British control, their wealth is primarily agricultural though gold and tin are also found, and are sufficiently similar to be considered together. They are essentially tropical well-watered countries with, in consequence, a rampant vegetation which, in the past, has dominated the population. This is relatively sparse, being only some 66 per sq. mile, and competition for land is consequently slight. The abundance of land which the nature of the climate renders suitable for the growth of all forms of tropical produce, soon attracted foreign capital and there has arisen a considerable plantation industry which is typically under company ownership. The main crop thus produced is rubber while oil palm and pineapples are receiving growing attention.

The tenure problems, thus, are dual and the principles are laid down in the Land Code (Enact. 11 of 1911) with its numerous amendments. These principles have been sufficiently described in the earlier series of studies. Briefly, agricultural land is classed in two groups according as the area is less or greater than 10 acres. Under the former falls land occupied by the indigenous peasantry and title is acknowledged by entry in the Mukim Register ; the latter includes the plantations and title is by document. Tenure falls short of full proprietary ownership ; rents are revisable in 1940 and subsequently at not less than 30 years' intervals. The right to transfer is granted but possession is dependent on conditions in respect to continuous cultivation. Ownership of the land is thus, definitely vested in the State.

As a consequence of the smallness of the population relative to the extent of the country, any pressure on the land is slight and there has been little need for regulation. The peasantry lead a self-contained life and, provided they fulfil the not too onerous terms of their tenure, the security in their land is assured. In two cases only has official action been taken. Rice forms the staple food of the people and any excessive export of this or the extension of the cultivation of other exchange cultures to the rice growing tracts would endanger their food supplies. The Cultivation of Rice Enactment in Negri Sembilan (N. S. 3 of 1917) and the Irrigated Areas Enactment (3 of 1922 and 37 of 1934) afford the necessary control, the latter giving power to notify tracts as irrigated areas in which cultivation is limited to rice. The second is the Agricultural Pests Enactment as applied to Perak and Pahang (7 of of 1934) and to Selangor and Negri Sembilan (6 of 1934) which empowers the Ruler of the State to appoint a Director of Agriculture with a supervisory committee to administer rules which follow the usual lines of such Enactments for protection from diseases and pests.

The wealth of the States, however, is founded in the plantation industry of which the important product is rubber. Developed, as has been stated through corporate action, the industry is largely capable of working out its own line of salvation and, in 1923, the Planters' Association of Malaya was organized as a corporate body under the Planters' Association of Malaya Incorporation Enactment (4 of 1923). This industry is organized on a typical plantation basis with paid labour which is supplied by immigration and the terms of employment are laid down in the Labour Code (18 of 1923), with numerous amendments consolidated in the later Labour Code (6 of 1933). This Code is a complicated document laying down the conditions of employment in great detail and making separate provision for the various types of labour employed, from India, China or the Dutch East Indies.

As is well known, the rubber industry has felt the effect of the world depression severely. Economy has been imperative and the organization of the industry on a plantation basis has enabled it to take advantage of that simplest of all methods, a reduction of the labour bill. This has been rendered possible because the *Hevea* rubber tree is little more than a generation removed from the wild plant, is a perennial and even benefits from a rest from tapping. Cultural operations can, under such conditions, be reduced to a minimum without serious depreciation while restrictions on output of rubber imposed by international agreement, implemented by the Rubber Regulation Enactment (17 and 39 of 1934), has further restricted the labour force required for tapping. Some indication of the retrenchment thus brought about is given by the immigration and emigration

figures over the period of depression though these apply to Malaya in general and not to the plantation industry particularly. The excess of immigrants over emigrants which persisted till 1929, turned to a deficit which amounted in 1930 and following years to 33.7, 187.5, 163.0 and 38.4 thousand. Only in 1934 did immigration again exceed emigration when the excess was 142,000 with 125,000 in 1935.

But the organization of the industry permitted other methods of meeting the situation created by the depression. The unit was, in many cases large enough to employ directly agricultural advisers while cooperative effort led to the establishment of the Rubber Research Institute in 1925 (Enact. 8 of 1925). By these means, following the lead of the Dutch in the Netherlands East Indies, a selection of high yielding rubber trees has been made, the art of budding studied and a number of high yielding clones established. With these, supplemented by importation of clonal material from the Netherlands East Indies, much of the rubber area is being planted up to yield at maturity a largely increased outturn of rubber per acre.

At the same time the depression emphasized the weakness of an industry in which, over a whole tract, dependence was placed on a single product. Again, following the lead of the Dutch, attention was turned to the oil palm and the young industry, which started about 1918, received an added impetus. This development was possible under the plantation conditions which permitted through access to the necessary capital, the factory equipment and the technical control for the output of a standardized product and, for this development, no legislative action has been required. The growth of this industry has been rapid. In 1918 a few acres only had been planted on a single estate. By 1924 the area had reached 5,000 acres and a measure of the increase is shown by the fact that exports of oil rose from 295 tons in 1924 to 29,296 tons in 1936 and 35,539 tons in 1937.

With reference to pineapples, legislative action has been taken under the Pineapple Industry Enactment (Sel. 2 of 1934), applicable to Selangor to control the marketing organization. Under this Enactment the factory is registered, a mark made compulsory and powers are taken to issue regulations dealing with methods of packing, standards of product and registration of brands.

Ceylon.

The tenure systems of Ceylon are probably more varied than in any other British Colony. Before the advent of the European, Ceylon was the seat of various ancient kingdoms, and titles to grants of land made by the rulers of these to individuals and families and for the service of temples are still extant. The services which originally attach to these tenures, have disappeared with time, as have many of the temples, but the tenure remains as a possessive right rather than as a trust and, not infrequently, the land has been alienated to the benefit of the holder. At a later period Ceylon has passed under the, at least partial, control of the Portuguese and Dutch and latterly, under the complete dominion of the British. Each has left its mark on the land system and land may be held under different codes of law.

Ceylon, too, is an island of diverse climate and, for the most part, is covered with a dense tropical vegetation in which man has had to fight nature. The staple food is rice and it is in the valleys and lowlands, where the cultivation of rice is most readily established on a permanent basis, that the tenure system, the individual rights in land, is most clearly defined. The village has its rice lands, but that is inadequate. A more or less nebulous area of highland forms an adjunct to the village in which rights are less well defined. This area is used for grazing, as a source of forest products, timber for houses and so on, and for shifting cultivation or chena. In the drier zones chena forms the dominant type of cultivation and rights here are ill defined as is usual in such cases.

That, beyond raising the usual questions associated with shifting cultivation such as the destruction of valuable forest and erosion, would have been of little consequence. The population was not excessive and the pressure on the land did not force questions of tenure to the fore. But the situation underwent a change during the second quarter of the nineteenth century when a demand arose for land for the cultivation of coffee and, later, tea and rubber. The cultivation of these was undertaken on a plantation basis with imported capital and, for the investment of that capital, security in the form of an assured title to the land was demanded. Adequate assurance could only be given by Government, but the areas for which Government had itself an assured right to grant titles were ill defined and the first effort to clear the position was made in the Crown Lands Ordinance (12 of 1840), an Ordinance which claimed all waste, unoccupied or uncultivated land and chena as Crown Land. There can be little doubt that, under this Ordinance and as the result of the ill defined position with regard to chena cultivation, much land was appropriated by the Crown to which the villages had a legitimate claim and that these villages were prejudiced thereby.

A period followed during which attempts were made to clear the position and to build up a record of accepted claims but the matter remained without satisfactory adjustment till 1897 when the growing value of land had led to so great an enhancement of encroachment, followed by sales of land unsupported by definitely accepted title with consequent litigation, that action appeared necessary. In that year was passed the Waste Lands Ordinance (1 of 1897) and two years later an amending Ordinance (1 of 1899). This Ordinance threw the onus of proving title on the claimant and was the subject of much criticism. This cannot be entered into here; a detailed account is to be found among the official records.*

* C 9370; Accts. and Papers, 1899, 58, p. 387.

In spite of these varied systems of tenure, it is possible to group agricultural land according as it falls into one of two classes. One of these includes that land which is held by individuals or companies largely alien, and worked on a plantation basis with a paid labour force mainly derived from India; the other is composed of land under peasant cultivation held either by individuals occupying the position of landlords, by family groups or by individual peasant holders grouped in villages. There is, thus, from the aspect of production, that sharp distinction so commonly found elsewhere of a peasant and a plantation system in juxtaposition. But, perhaps more markedly than elsewhere and especially as the result of fractionation of holdings and the rigid limitation of village waste and chena, freedom for expansion with a growing population is inadequately provided for. The peasant holding, especially of rice land, is too small to provide even the needs of the producer* who is forced to purchase and the home supply has to be reinforced by import. The peasant himself secures maintenance only by labour or by disposal of the only produce of the few trees he can grow on his holding, namely coconuts. In the majority of cases there is no question of the provision of more than sufficient for maintenance and Government is forced back to subserve one of its primary functions, the protection of the food supply of the people. In 1937 was passed the Food Control Ordinance (22 of 1937) which empowered the Governor to appoint a food controller with powers to regulate the movement of food and articles of food from places where shortage might be anticipated. The provision of those material requirements which follow a development of a higher standard of living hardly as yet enters the picture.

Meanwhile the broader issue was being faced. The Waste Lands Ordinance was replaced by a further Ordinance (8 of 1927) in turn to be replaced by the Land Settlement Ordinance (20 of 1931) which, as amended (22 of 1932), appointed a Land Settlement Officer. Under it, Crown Land was to be demarcated for communal chena and permission to use this for other purposes was to be allowed only with the consent of the villagers. More recently the problem has been attacked in a still more comprehensive manner under the Land Development Ordinance (19 of 1935). This Ordinance appoints a Land Commissioner whose function is to map out Crown Land for village expansion, forest, pasture, and chena cultivation and for colonization, forest reserves, roads, towns, &c. Under him are local advisory committees for the preparation of schemes. Alienation is to be by permit or grant, the former bearing a personal title ceasing with death, the latter permitting disposal only with the consent of the Government Agent. Terms relative to use are included in the grant or permit which are liable to cancellation if the terms are not fulfilled. Among the obligatory terms common to both are, a ban on subdivision below a specified minimum regular cultivation except in the case of chena and payment of a specified annual rent while further conditions such as precautions against erosion may be inserted. Under this Ordinance provision is made for settlement schemes to absorb displaced labour resulting from the depression* and, in connection therewith, marketing departments to provide markets for the produce of the settlers.†

As has been noted, the only important exchange products raised by the peasant are from the coconut and efforts to foster the market for these are incorporated in the Coconut Products Ordinance (13 of 1935). Under it is established a Ceylon Coconut Board as a corporate body with varied functions including the power to acquire, hold, sell or lease properties, to advertise coconut products, to aid and finance associations and cooperative societies to promote and subsidize factories, to establish auctions (in the first place daily in Colombo), to register brokers and agents, shippers, dealers and millers and to issue export licences. Funds are provided by a cess of 2.5 cents per cwt. copra, 4 cents per cwt. coconut oil and 3.5 cents per cwt. desiccated coconut. The Cooperative Societies to which reference is made in the above Ordinance are regulated by the Cooperative Societies Ordinance (16 of 1936) which repealed the earlier Ordinance (34 of 1921).

The peasant, as a self contained unit, has suffered relatively little from the world depression and the measures above described are directed less to save him from the impact of that depression than to open to him a road by which he may secure a higher standard of living. The plantation industry, on the contrary, has been exposed to the full effects of the economic storm but, from its organization, has been able, if only with difficulty to absorb the shock with only such official action as was required to enforce an uniform system of controlled production both of rubber and tea. Among the internal measures adopted was that simplest of all economies, a reduction of the labour force, the effects of which can be traced in the change from an excess of immigrants to an excess of emigrants. This change made its appearance in 1930 and continued to 1935.

But further steps were taken to put the plantation industry on a more secure basis. For the tea industry a Tea Research Institute was established under the Tea Research Ordinance (12 of 1925) which laid down the constitution of a Research Board and imposed a duty of 10 cents per 100 lbs. exported to provide the necessary funds. A Rubber Research Ordinance (10 of 1930), provided a like Institute for the rubber industry with funds derived from an export duty of 0.1 cent per lb., while the Coconut Research Ordinance (29 of 1928) played a similar rôle for the coconut industry, the export duty in this case being 1.75 cents per cwt. on desiccated coconut, 1.875 cents per cwt. on coconut oil, 1.25 cents per cwt. on copra and 5 cents per 1,000 fresh coconuts.

(*To be continued.*)

* Board Agric., Ceylon; Rep. of District Subcommittees, to enquire into Paddy Cultivation, 1930.

* Ann. Rep. (1932), 1652. † Ann. Rep. (1934), 1732.

AN APPRECIATION—SIR GEOFFREY EVANS, C.I.E., M.A.

ALL those who are or have been in any way connected with the Imperial College of Tropical Agriculture, will regret to hear that Sir Geoffrey Evans, Principal since 1927, is leaving Trinidad to take up an appointment as Economic Botanist at Kew, for Sir Geoffrey has been so long and so closely connected with the work of the College that it is difficult to picture the place without him. When Sir Geoffrey took over the Principal's Office, the College had been in existence only a short time. Its buildings were incomplete, its area was limited, and its curriculum was in many ways inadequate. That the College stands in the position it does today, is a testimony of the enthusiastic way in which Sir Geoffrey devoted himself to its interests, and it can rarely have been the case that a College has been so definitely identified with its Principal.

Sir Geoffrey had a distinguished career behind him when he came to Trinidad. One of the early band of stalwarts who laid the foundations of the Indian Agricultural Service, he went out to India in the autumn of 1906, and was posted to the Central Provinces. After a short spell as Principal of the Agricultural College at Nagpur, he became Deputy Director of Agriculture, Northern Circle. Here he made his mark as a skilful wheat breeder, and further acquired the reputation of a thoroughly efficient and popular District Officer. The intimate knowledge of his district which he possessed, was recognised when, in the early days of the Great War, he was made a recruiting officer. Later, as an officer in the Indian Army Reserve, Sir Geoffrey saw active service in Mesopotamia, where he quickly obtained the rank of Colonel and served as Director of Agriculture to the Mesopotamian Expeditionary Force, being mentioned in dispatches and being rewarded by the C.I.E. On his return to India, he became Director of Agriculture in Bengal and from 1919 to 1922 administered the agricultural affairs of this large and very important province. He left India to take up work in 1923 under the Empire Cotton Growing Corporation and was employed by them as Director of Cotton Culture to the Queensland Government, with headquarters at Sydney. His work here not only included the help which he was authorised to make to the cotton growers of Queensland, but took him further afield to investigate the possibilities of cotton growing in Fiji and New Guinea, and led him into many adventures by air, sea and land. He left Australia in 1926 to come to Trinidad. It will be realised from this brief account that Sir Geoffrey was well equipped for the post of Principal, and indeed the College can look back on a decade, if not of prosperity, at least of progress, and progress in the face of considerable difficulties. It is no secret that the College has no endowment, and that it has been a matter of considerable difficulty, especially during the last five years, to make the budget balance. In consequence, Sir Geoffrey has been considerably hampered in his schemes for development and has had the disappointment of seeing many of his proposals negatived for lack of funds.

His success has been largely due to his personality. Under the graver demeanour of a Principal, those who knew him in his younger days could recognise the geniality which made him known to his friends as "George", an abbreviation for "Farmer George". His personal popularity was great, his courtesy unfailing. The numerous trophies which decorated his house at the College, bear witness to his skill as a Shikari. The magnificent tiger-skin came from an animal which fell to his weapon in peculiar circumstances, about which his lips were sealed for many years. A keen fisherman and a great walker, he entered wholeheartedly into the sporting life of the College and was a regular spectator at College football and hockey matches.

To Lady Evans we have also to bid farewell. Those who experienced it, will not easily forget the hospitality which she so ably assisted Sir Geoffrey to dispense, and their wonderful Christmas parties will remain a pleasant memory to all those students who helped to make them successful. Both his daughters spent some time with their parents in Trinidad, and though their stay was brief, they both made many friends.

The College owes them much and it is to be hoped that if and when an endowment becomes a reality, some portion of it will be definitely associated with their names. Sir Geoffrey was at heart a farmer and this should be remembered in considering any memorial it is desired to institute to remind future students of the great part he played, not only in the material development of the College, but the founding of a tradition of which the Colonial Agricultural Service may well be proud. All happiness to Sir Geoffrey and Lady Evans and their daughters in their new life.

R. C. W.

NUTRITIVE VALUE OF PAPAYA.

1. Papayas (*Carica Papaya*) grown in Hawaii have been analysed for organic nutrients, calcium, phosphorus, iron, chlorine and acid-base balance. 2. Papaya compares favourably with oranges as a source of calcium, basic ash and ascorbic acid. 3. The vitamin C content of papaya increases with ripeness. 4. Average papaya is estimated to contain per 100 g. of edible material, 2,500 international units of vitamin A, 8 international units of vitamin B1, 70 mg. of ascorbic acid (vitamin C) and 33 Bourquin-Sherman units of vitamin B2 (G). —(*Imp. Bur. of Hort. and Plantation Crops*, Vol. VIII, No. 1. Abs. 199, p. 59, 1938.)

Photo by *Swaine Ltd.*

SIR GEOFFREY EVANS, C.I.E., M.A.

THE IMPORTANCE AND USE OF APPROPRIATE ASSUMED MEANS IN COLLATING FIELD EXPERIMENTAL RESULTS STATISTICALLY.

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The desirability of using assumed means in the statistical analysis of agricultural experimental data has been recognised and stressed by many competent authorities.

Fisher and Wishart (1930) state "The unnecessarily laborious process is sometimes adopted of subtracting from each plot yield in turn the exact value of the general mean, retaining sufficient decimal places, and squaring all the differences. The result obtained in this way is correct, but it may be arrived at in most cases much more rapidly by using not the exact general mean, but some other 'working mean'.

Often the working mean may be taken to be zero, in which case we merely add up the squares of the recorded yields, avoiding all labour of subtraction. This is usually quite a suitable procedure, using a machine or a table of squares, such as Barlow's, which gives the exact squares of all four-figure numbers; it does, however, involve usually an unnecessarily large number of figures. For example, if the yields all lie between 350 and 450 units, the squares of these numbers as they stand will be of 6 figures each, whereas if we had taken the difference from 400 before squaring we should never need more than 4 figures. Rapidity of working is much increased if the numbers to be squared are small enough for their squares to be written down at sight".

Love (1936) states "This method (using an assumed mean) is preferable . . . since we are dealing with smaller numbers . . . and the multiplication and addition are simpler. It should be kept in mind that as a rule the smaller the numbers to be used in calculations the greater will be the accuracy of the results".

Fisher and Wishart (1930), Love (1936), Paterson (1933), Shaw (1936) and others give detailed examples for the use of assumed means in dealing with the results of single experiments, but it frequently happens that the experimenter wishes to combine the results from one trial over several seasons or several trials at different sites over several seasons.

In work with sugar-cane, for example, it may be desirable to know the effect of varying doses of manures on plant canes, first and second ratoons (stubble crops), and three or four different experiments may be spread over a considerable area in an attempt to secure a general answer for the district.

If now it be remembered that the yield from a field of sugar-cane usually diminishes steadily at each successive harvest, until the field is replanted, and also that the yield may vary considerably from experimental site to site (although the relative effect of the manurial doses may be much the same), it will be obvious that the use of a single assumed mean for all the trials and seasons will hardly be of much assistance in reducing the statistical labour.

In the present article it is proposed to show the detailed working of the combination of results from several trials and seasons where an 'appropriate assumed mean' is used for each set of the component data; this being done for

(1) a combination including first order interactions, and

(2) a combination including first and second order interactions.

If Table I and Table II are contrasted it is obvious that the work will be much more laborious, owing to large numbers, if the statistical examination of the data is carried out on the yield figures as they stand in Table I or on those figures less a single assumed mean, rather than on the small deviations of Table II obtained by the use of appropriate means for each harvest.

The examples are taken as far as the column "Sums of Squares" in the Tables of Analysis of Variance. From that stage the calculations follow the usual lines.

In the analysis of variance presented at the close of each combination will be found, marked with an asterisk, those interactions where a considerable saving of the use of cumbersome figures and calculations was made possible by employing 'appropriate assumed means'. The greater the variation in yield from site to site and season to season, the greater will be the advantage of using separate assumed means.

The data used are those given by Shaw (1936) for yields of Pusa oats in lb. from plots of 1,000 sq. ft., the experiments having been carried out at Pusa and Karnal in 1931-32, 1932-33 and 1933-34.

Combination of Pusa Harvest for 1931-32, 1932-33 and 1933-34.

(*Including First Order Interactions.*)

The actual yields are arranged according to Varieties, Blocks, Seasons and Localities, as shown in Table I, which has been copied from Shaw.

An appropriate assumed mean is now subtracted from the plot yields of each harvest (Season) and Locality. This has been done in Table II.

To avoid confusion and repetition, the complete tables have been published at this point but for the purpose of this section, only the results obtained at Pusa are needed.

Table I.—Yields of Pusa Oats in lb. from Plots 1,000 Square Feet in Area.

Locality.	Seasons.	Blocks.	Varieties. A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	Block Totals.
Pusa ...	1931-32 ...	1	26.5	35.0	29.5	39.5	39.5	43.0	37.0	30.5	28.5	36.5	26.5	51.0	43.0	466.0
		2	38.0	28.5	24.0	24.0	31.5	44.5	33.0	18.5	26.0	38.5	40.0	59.0	28.5	434.0
		3	22.5	23.0	23.5	21.0	26.5	26.0	22.0	22.0	27.0	30.5	24.0	39.0	29.5	336.5
		4	18.0	17.5	19.5	22.0	27.0	28.0	31.5	18.5	19.5	25.0	23.0	34.0	32.0	315.5
		5	22.5	19.5	25.5	25.0	30.0	32.5	27.5	21.5	15.5	28.5	22.5	38.5	28.0	337.0
		Totals ...	127.5	123.5	122.0	131.5	154.5	174.0	151.0	111.0	116.5	159.0	136.0	221.5	161.0	1,889.0
	1932-33 ...	1	37.5	25.0	61.0	35.0	44.5	48.5	53.0	41.0	54.5	61.0	36.5	59.0	59.0	615.5
		2	31.5	27.5	55.5	36.0	47.0	48.5	55.5	27.5	47.0	56.5	41.0	53.5	59.0	586.0
		3	28.0	30.5	61.0	46.0	37.0	58.0	57.0	32.5	51.0	58.5	28.0	51.0	54.5	593.0
		4	32.5	34.5	60.0	51.0	50.5	47.5	55.0	37.5	62.5	56.5	33.0	55.5	54.0	630.0
		5	40.5	29.5	58.0	57.5	52.5	49.0	51.5	31.5	53.5	51.0	47.5	42.5	59.5	624.0
		Totals ...	170.0	147.0	295.5	225.5	231.5	251.5	272.0	170.0	268.5	283.5	186.0	261.5	286.0	3,048.5
	1933-34 ...	1	37.5	30.5	68.0	41.0	47.0	43.0	52.5	42.5	44.5	49.5	42.5	61.5	66.0	626.0
		2	48.0	35.5	71.0	52.0	57.0	48.5	55.5	51.5	55.5	55.5	46.5	57.5	57.5	691.5
		3	49.0	38.0	67.5	52.5	57.5	48.5	59.0	48.0	52.0	51.5	48.5	55.0	63.5	690.5
		4	54.0	38.5	68.5	54.5	60.0	49.0	57.0	52.5	54.0	56.5	49.0	69.0	70.0	732.5
		5	48.0	32.0	64.5	49.5	49.0	38.0	56.5	48.0	48.0	67.5	42.5	54.5	62.0	660.0
		Totals ...	236.5	174.5	339.5	249.5	270.5	227.0	280.5	242.5	254.0	280.5	229.0	297.5	319.0	3,400.5
Variety Totals for Pusa		...	534.0	445.0	757.0	606.5	656.5	652.5	703.5	523.5	639.0	723.0	551.0	780.5	766.0	8,338.0

Table I.—*Continued.*—**Yields of Pusa Oats in lb. from Plots 1,000 Square Feet in Area.**

Locality.	Seasons.	Blocks.	Varieties. A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	Block Totals.
Karnal ...	**1931-32** ...	**1** ...	44.5	29.0	44.0	48.5	42.0	30.5	50.5	40.5	41.0	46.5	51.5	19.0	38.0	525.5
		2 ...	34.5	37.0	42.5	39.0	40.5	44.0	47.0	43.0	29.5	53.5	45.5	34.5	25.5	516.0
		3 ...	43.0	27.0	36.0	38.5	33.5	32.5	44.5	39.0	31.5	37.5	30.0	38.0	36.0	467.0
		4 ...	42.0	23.0	46.0	42.0	26.5	34.0	44.0	33.5	36.0	42.0	34.0	39.5	44.0	486.5
		5 ...	42.5	30.5	42.0	35.0	36.0	31.0	32.5	26.5	26.0	42.0	36.0	28.0	34.5	442.5
		Totals ...	206.5	146.5	210.5	203.0	178.5	172.0	218.5	182.5	164.0	221.5	197.0	159.0	178.0	2,437.5
	1932-33 ...	**1** ...	29.0	27.5	36.0	30.5	35.0	36.0	46.0	27.5	33.0	45.0	32.0	56.5	55.0	489.0
		2 ...	36.0	22.0	48.0	45.0	43.0	34.0	48.0	33.0	34.0	57.0	38.0	47.0	58.0	543.0
		3 ...	38.0	29.5	47.0	48.0	48.0	42.0	52.0	45.0	36.0	57.0	42.0	64.0	62.0	610.5
		4 ...	40.0	29.5	55.0	45.5	50.0	40.0	57.0	43.5	40.5	50.5	40.5	65.0	52.5	609.5
		5 ...	40.0	22.0	52.5	48.5	42.0	35.5	48.0	31.0	34.5	59.0	40.0	47.0	60.0	560.0
		Totals ...	183.0	130.5	238.5	217.5	218.0	187.5	251.0	180.0	178.0	268.5	192.5	279.5	287.5	2,812.0
	1933-34 ...	**1** ...	40.0	27.0	38.5	38.5	34.0	34.5	35.5	33.5	35.5	37.5	39.5	39.5	40.5	474.0
		2 ...	36.5	26.5	38.5	32.0	35.0	33.0	38.5	30.5	40.5	37.5	32.5	35.0	50.0	466.0
		3 ...	39.5	34.0	42.0	48.0	43.5	43.0	41.5	37.5	41.0	39.0	35.5	45.0	49.5	539.0
		4 ...	45.5	31.0	42.0	36.5	48.5	46.5	48.0	39.5	48.5	49.5	40.0	53.0	56.5	585.0
		5 ...	55.5	37.5	57.5	50.0	52.5	52.5	54.5	43.0	51.0	47.0	54.0	46.0	56.5	657.5
		Totals ...	217.0	156.0	218.5	205.0	213.5	209.5	218.0	184.0	216.5	210.5	201.5	218.5	253.0	2,721.5
Variety Totals for Karnal			606.5	433.0	667.5	625.5	610.0	569.0	687.5	546.5	558.5	700.5	591.0	657.0	718.5	7,971.0
Combined Variety Totals for Pusa and Karnal			1140.5	878.0	1424.5	1232.0	1266.5	1221.5	1391.0	1070.0	1197.5	1423.5	1142.0	1437.5	1484.5	16,309.0

Table II.—Yields of Pusa Oats in lb. from Plots 1,000 Square Feet in Area.

Locality.	Seasons.	Blocks.	Varieties. A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	Block Totals.	Crude Total Sums of Squares.
			Assumed Mean of 30.0 lb.														
Pusa ...	**1931-32**...	**1**	−3.5	5.0	−0.5	9.5	9.5	13.0	7.0	0.5	−1.5	6.5	−3.5	21.0	13.0	76.0	
		2	8.0	−1.5	−6.0	−6.0	1.5	14.5	3.0	−11.5	−4.0	8.5	10.0	29.0	−1.5	44.0	
		3	−7.5	−7.0	−6.5	−9.0	−3.5	−4.0	−8.0	−8.0	−3.0	0.5	−6.0	9.0	−0.5	−53.5	
		4	−12.0	−12.5	−10.5	−8.0	−3.0	−2.0	1.5	−11.5	−10.5	−5.0	−7.0	4.0	2.0	−74.5	
		5	−7.5	−10.5	−4.5	−5.0	—	2.5	−2.5	−8.5	−14.5	−1.5	−7.5	8.5	−2.0	−53.0	
		Totals ...	−22.5	−26.5	−28.0	−18.5	4.5	24.0	1.0	−39.0	−33.5	9.0	−14.0	71.5	11.0	−61.0	4,605.50
			Assumed Mean of 45.0 lb.														
	1932-33...	**1**	−7.5	−20.0	16.0	−10.0	−0.5	3.5	8.0	−4.0	9.5	16.0	−8.5	14.0	14.0	30.5	
		2	−13.5	−17.5	10.5	−9.0	2.0	3.5	10.5	−17.5	2.0	11.5	−4.0	8.5	14.0	1.0	
		3	−17.0	−14.5	16.0	1.0	−8.0	13.0	12.0	−12.5	6.0	13.5	−17.0	6.0	9.5	8.0	
		4	−12.5	−10.5	15.0	6.0	5.5	2.5	10.0	−7.5	17.5	11.5	−12.0	10.5	9.0	45.0	
		5	−4.5	−15.5	13.0	12.5	7.5	4.0	6.5	−13.5	8.5	6.0	2.5	−2.5	14.5	39.0	
		Totals ...	−55.0	−78.0	70.5	0.5	6.5	26.5	47.0	−55.0	43.5	58.5	−39.0	36.5	61.0	123.5	7,878.75
			Assumed Mean of 52.0 lb.														
	1933-34...	**1**	−14.5	−21.5	16.0	−11.0	−5.0	−9.0	0.5	−9.5	−7.5	−2.5	−9.5	9.5	14.0	−50.0	
		2	−4.0	−16.5	19.0	—	5.0	−3.5	3.5	−0.5	3.5	3.5	−5.5	5.5	5.5	15.5	
		3	−3.0	−14.0	15.5	0.5	5.5	−3.5	7.0	−4.0	—	−0.5	−3.5	3.0	11.5	14.5	
		4	2.0	−13.5	16.5	2.5	8.0	−3.0	5.0	0.5	2.0	4.5	−3.0	17.0	18.0	56.5	
		5	−4.0	−20.0	12.5	−2.5	−3.0	−14.0	4.5	−4.0	−4.0	15.5	−9.5	2.5	10.0	−16.0	
		Totals ...	−23.5	−85.5	79.5	−10.5	10.5	−33.0	20.5	−17.5	−6.0	20.5	−31.0	37.5	59.0	20.5	5,687.75
Variety Totals for Pusa ...			−101.0	−190.0	122.0	−28.5	21.5	17.5	68.5	−111.5	4.0	88.0	−84.0	145.5	131.0	83.0	

Table II—*Continued.*—**Yields of Pusa Oats in lb. from Plots 1,000 Square Feet in Area.**

Locality.	Seasons.	Blocks.	Varieties. A.	B.	C.	D.	E.	F.	G.	H.	I.	J.	K.	L.	M.	Block Totals.	Crude Total Sum of Squares.
			Assumed Mean of 37.0 lb.														
Karnal ...	1931-32...	1	7.5	−8.0	7.0	11.5	5.0	−6.5	13.5	3.5	4.0	9.5	14.5	−18.0	1.0	44.5	
		2	−2.5	—	5.5	2.0	3.5	7.0	10.0	6.0	−7.5	16.5	8.5	−2.5	−11.5	35.0	
		3	6.0	−10.0	−1.0	1.5	−3.5	−4.5	7.5	2.0	−5.5	0.5	−7.0	1.0	−1.0	−14.0	
		4	5.0	−14.0	9.0	5.0	−10.5	−3.0	7.0	−3.5	−1.0	5.0	−3.0	2.5	7.0	5.5	
		5	5.5	−6.5	5.0	−2.0	−1.0	−6.0	−4.5	−10.5	−11.0	5.0	−1.0	−9.0	−2.5	−38.5	
		Totals ...	21.5	−38.5	25.5	18.0	−6.5	−13.0	33.5	−2.5	−21.0	36.5	12.0	−26.0	−7.0	32.5	3,396.25
			Assumed Mean of 43.0 lb.														
	1932-33...	1	−14.0	−15.5	−7.0	−12.5	−8.0	−7.0	3.0	−15.5	−10.0	2.0	−11.0	13.5	12.0	−70.0	
		2	−7.0	−21.0	5.0	2.0	—	−9.0	5.0	−10.0	−9.0	14.0	−5.0	4.0	15.0	−16.0	
		3	−5.0	−13.5	4.0	5.0	5.0	−1.0	9.0	2.0	−7.0	14.0	−1.0	21.0	19.0	51.5	
		4	−3.0	−13.5	12.0	2.5	7.0	−3.0	14.0	0.5	−2.5	7.5	−2.5	22.0	9.5	50.5	
		5	−3.0	−21.0	9.5	5.5	−1.0	−7.5	5.0	−12.0	−8.5	16.0	−3.0	4.0	17.0	1.0	
		Totals ...	−32.0	−84.5	23.5	2.5	3.0	−27.5	36.0	−35.0	−37.0	53.5	−22.5	64.5	72.5	17.0	6,908.00
			Assumed Mean of 42.0 lb.														
	1933-34...	1	−2.0	−15.0	−3.5	−3.5	−8.0	−7.5	−6.5	−8.5	−6.5	−4.5	−2.5	−2.5	−1.5	−72.0	
		2	−5.5	−15.5	−3.5	−10.0	−7.0	−9.0	−3.5	−11.5	−1.5	−4.5	−9.5	−7.0	8.0	−80.0	
		3	−2.5	−8.0	—	6.0	1.5	1.0	−0.5	−4.5	−1.0	−3.0	−6.5	3.0	7.5	−7.0	
		4	3.5	−11.0	—	−5.5	6.5	4.5	6.0	−2.5	6.5	7.5	−2.0	11.0	14.5	39.0	
		5	13.5	−4.5	15.5	8.0	10.5	10.5	12.5	1.0	9.0	5.0	12.0	4.0	14.5	111.5	
		Totals ...	7.0	−54.0	8.5	−5.0	3.5	−0.5	8.0	−26.0	6.5	0.5	−8.5	8.5	43.0	−8.5	3,758.75
Variety Totals for Karnal ...			−3.5	−177.0	57.5	15.5	0	−41.0	77.5	−63.5	−51.5	90.5	−19.0	47.0	108.5	41.0	0
Combined Variety Totals for Pusa and Karnal ...			−104.5	−367.0	179.5	−13.0	21.5	−23.5	146.0	−175.0	−47.5	178.5	−103.0	192.5	239.5	124.0	32,235.00

The S.S. due to Seasons for the trial at Pusa which was reaped at different periods is calculated by squaring the Season totals, 1889.0, 3048.5, 3400.5, from Table I, adding and dividing by 65 to give 375,770.3615 and subtracting the correction 356,524.3282 (which is the grand total 8338.0 squared and divided by 195), thus leaving 19,246.0333 as the net S.S. for Seasons.

The Total S.S. for the combined results of the three harvests at Pusa is found by adding the crude sum of squares for each result (*see* Table II) or 4,605.50 plus 7,878.75 plus 5,687.75 giving 18,172.0000; then subtracting a correction, 298.3615, for the effect of using different assumed means in different Seasons. (The correction is found by squaring the Seasonal totals −61.0, 123.5 and 20.5, adding and then dividing by 65.) The next step is to add to the result, the S.S. due to Seasons, or the figure 19,246.0333, thus giving 37,119.6718 as the Total S.S. for the combined results.

The S.S. for Varieties is found by squaring the Variety grand totals for Pusa from Table II, summing these squares, dividing by 15 and subtracting the general correction 35.3282 (this being found by squaring the grand total deviation 83.0 and dividing by 195). The remainder, 8,833.8385 is the S.S. due to varieties for the combined results.

To find the S.S. for Blocks it is necessary to construct Table III from the yields obtained at Pusa as recorded in Table II.

Table III.—Blocks × Seasons.

Seasons.	Blocks. 1	2	3	4	5	Total.
1931-32	76.0	44.0	−53.5	−74.5	−53.0	−61.0
1932-33	30.5	1.0	8.0	45.0	39.0	123.5
1933-34	−50.0	15.5	14.5	56.5	−16.0	20.5
Total	56.5	60.5	−31.0	27.0	−30.0	83.0

The S.S. for Blocks is found by squaring the block totals in the above table, adding their squares to give 9,442.50, dividing by 39 to give 242.1154 and then subtracting the general correction 35.3282 (mentioned before) to leave 206.7872 as the S.S. for Blocks.

The S.S. for the first order interaction Blocks × Seasons is arrived at by squaring the figures 76.0 . . . −53.0; 30.5 . . . 39.0; −50.0 . . . −16.0; from Table III, adding their squares and dividing by 13 to give 2,297.9615; then subtracting 298.3615 (the correction for the effect of varying assumed means) and 206.7872 the S.S. for Blocks. The figure 1,792.8128 is left as the S. S. for the interaction Blocks × Seasons.

The S.S. for the first order interaction Varieties × Seasons is found by squaring the variety totals for each season, −22.5 . . . 11.0; −55.0 . . . 61.0; −23.5 . . . 59.0; as shown in the sub-totals of Table II, adding the squares and dividing by 5 to give 13,111.1000; then subtracting 298.3615 (the correction for the effect of varying assumed means) and 8,833.8385, the S.S. for Varieties, to leave 3,978.9000 as the S. S. for the Varieties × Seasons interaction.

To find the S.S. for the first order interaction Blocks × Varieties it is necessary to compute the figures as presented in Table IV from those shown in Table II, by summing the yields of each variety over the three harvests by blocks.

Table IV.—Combined Blocks × Varieties (Pusa Yields Alone).

Blocks.	Varieties. A.	B.	. . .	M.	Block Totals.
1 ...	−25.5	−36.5	. . .	41.0	56.5
2 ...	− 9.5	−35.5	. . .	18.0	60.5
3 ...	−27.5	−35.5	. . .	20.5	−31.0
4 ...	−22.5	−36.5	. . .	29.0	27.0
5 ...	−16.0	−46.0	. . .	22.5	−30.0
Combined Variety Totals ... (Pusa)	−101.0	−190.0	. . .	131.0	83.0

The figures −25.5 . . . 41.0; −9.5 . . . 18.0; −27.5 . . . 20.5; −22.5 . . . 29.0; and −16.0 . . . 22.5 from Table IV are then squared, the squares totalled and divided by 3 to give 10,004.6667. Then the general correction, 35.3282, the S.S. for Varieties, 8,833.8385, and the S.S. for Blocks, 206.7872, are subtracted, thus leaving 928.7128 as the S.S. for this interaction.

The S.S. for Error (Blocks × Varieties × Seasons) is obtained by finding the difference between the Total S.S. for the combined results and the sum of the S.S. for Seasons, Varieties, Blocks and the three first order interactions just discussed.

The following table summarises the Sums of Squares for the combined results of the harvests at Pusa.

Table V.—Sums of Squares for Combined Results at Pusa.

Variance due to :—	Degrees of Freedom.	Sums of Squares.
Blocks	4	206.7872
Varieties	12	8,833.8385
Seasons	2	19,246.0333
*Varieties × Seasons ...	24	3,978.9000
*Blocks × Seasons ...	8	1,792.8128
Blocks × Varieties ...	48	928.7128
Error (Blocks × Varieties × Seasons)	96	2,132.5872
*Total ...	194	37,119.6718

* *Previously explained*

Table VI gives the S.S. for Varieties, Blocks, Error and Total for the individual harvests from the Pusa Locality.

Table VI.—Individual Analyses of the Various Harvests at Pusa.

Variance due to:—	Degrees of Freedom.	Sums of Squares for the Seasons.		
		1931-32	1932-33	1933-34
Varieties	12	2,159.8538	6,154.7000	4,498.1846
Blocks ...	4	1,399.1769	114.6769	485.7461
Error ...	48	989.2231	1,374.7231	697.3539
Total	64	4,548.2538	7,644.1000	5,681.2846

It is to be noted that the Total S.S. for the individual harvests, when summed, are identical with the Total S.S. for the combined results less the S.S. for Seasons.

Of interest also is the fact that the S.S. for Error for individual harvests are identical, when totalled, with the sum of the S.S. due to the interaction Blocks × Varieties and the Error (Blocks × Varieties × Seasons) for the combined results.

Another agreement is found when the S.S. for Blocks for individual harvests are totalled and compared with the S.S. for Blocks and Blocks × Seasons for the combined results. A similar agreement is found when the S.S. for varieties for the individual harvests are totalled and compared with the S.S. for Varieties and Varieties × Seasons for the combined results.

Combination of Pusa and Karnal Harvests for 1931-32, 1932-33 and 1933-34.

(*Including First and Second Order Interactions.*)

In Table II are set out the deviations of the yields of Pusa oats in lb. per 1,000 sq. ft. in area, from appropriate assumed means for each harvest and site.

The assumed means entailed in arriving at these deviations vary considerably. The total deviations set out under each reaping are, therefore, not indicative of the true variation of the yields from harvest to harvest and site to site. The S.S. for Localities, Seasons and Localities × Seasons must be obtained by using the actual total yields for each harvest, as shown in Table I and summarised in Table VII.

Table VII.—Localities and Seasons.

Localities.	Seasons.			Total.
	1931-32.	1932-33.	1933-34.	
Pusa ...	1,889.0	3,048.5	3,400.5	8,338.0
Karnal ...	2,437.5	2,812.0	2,721.5	7,971.0
Total ...	4,326.5	5,860.5	6,122.0	16,309.0

The S.S. for Localities is arrived at by squaring the totals 8,338.0 and 7,971.0, adding, dividing by 195 and subtracting the general correction ($16,309.0^2$ divided by 390), *i.e.*, 682,354.2820 minus 682,008.9256 (correction), giving 345.3564.

The S.S. for Seasons will be found by squaring the totals 4,326.5, 5,860.5 and 6,122.0, adding, dividing by 130 and subtracting the same general correction as for Localities, *i.e.*, 696,484.2038 minus 682,008.9256 (correction), giving 14,475.2782.

The S.S. for the interaction between Seasons and Localities is found by squaring the figures 1,889.0, 3,048.5, 3,400.5, 2,437.5, 2,812.0 and 2,721.5, adding their squares, dividing by 65, subtracting the general correction and also subtracting the S.S. for Localities and Seasons, *i.e.*, 702,775.1692 minus 682,008.9256 (correction), 14,475.2782 (S.S. for Seasons) and 345.3564 (S.S. for Localities), leaving 5,945.6090 as the S.S. for the interaction.

The Total S.S. for the combined results of the various harvests is found by taking the grand total of the crude sums of squares for both Pusa and Karnal as shown in Table II, subtracting the general correction for all harvests (this being found by squaring the figures −61.0, 123.5, 20.5, 32.5, 17.0, −8.5 and then dividing by 65, each being a total of 65 deviations) and then adding the S.S. for Localities, Seasons and their interactions, *i.e.*, 32,235.00 minus 320.1692 (correction) plus 345.3564, 14,475.2782 and 5,945.6090 giving 52,681.0744 for Total S.S.

The S.S. due to the variation between Varieties for the combined results is obtained by squaring the combined Pusa and Karnal totals for each variety in Table II, adding, dividing by 30 and subtracting the general correction for the combined yields, *i.e.*, square the figures −104.5, −367.0 . . . 239.5 and add to give 370,098.00, divide by 30 to give 12,336.6000 and then subtract the correction 39,4256 (this being found by squaring 124.0 which is the grand total deviation for the results and dividing by 390 which is the total number of plot deviations) thus leaving 12,297.1744 as the S.S. for Varieties.

The S.S. for the first order interaction between Varieties and Localities is found by squaring the totals for each variety for the three harvests at each locality as shown in Table II, adding, dividing by 15, subtracting the correction for the effect of both Pusa and Karnal and then subtracting the S.S. due to Varieties; *i.e.*, square −101.0 . . . 131.0 (Pusa variety totals) −3.5 . . . 108.5 (Karnal variety totals), add to give 204,829.50, divide by 15 to give 13,655.30, deduct the correction for the effect of Localities and the use of varying assumed means 43.9487 (this being found by squaring 83.0 and 41.0, adding, and then dividing by 195) and also the S.S. for Varieties 12,297.1744, leaving 1,314.1769 as the S.S. for the interaction.

Before attempting to calculate the S.S. for the interaction between Varieties and Seasons, it is necessary to construct Table VIII. Its data are easily computed from Table II, *i.e.*, to arrive at the figure −1.0 for Variety A and Season 1931-32, add the deviation yields for Variety A from Table II for the season 1931-32 for both Localities, *i.e.*, −22.5 plus 21.5.

Table VIII.—Varieties and Seasons.

Seasons	Varieties.				Total.
	A.	B.	. . . .	M.	
1931-32 ...	− 1.0	−65.0	. . . .	4.0	−28.5
1932-33 ...	−87.0	−162.5	. . . .	133.5	140.5
1933-34 ...	−16.5	−139.5	. . . .	102.0	12.0
Total...	−104.5	−367.0	. . . .	239.5	124.0

The S.S. for the interaction between Varieties and Seasons is computed by squaring the figures −1.0 . . . 4.0; −87.0 . . . 133.5; −16.5 . . . 102.0; adding and dividing by 10 to give 16,295.4000, subtracting 159.2038, the correction for the effect of Seasons and the use of varying assumed means (this being found by squaring the figures −28.5, 140.5 and 12.0, the totals for Seasons in Table VIII, adding and then dividing by 130); and then reducing the result obtained, by the figure 12,297.1744, the S.S. obtained for the variation between varieties, thus leaving 3,839.0218 for the S.S. due to the interaction between Varieties and Seasons.

The S.S. due to Blocks and their interaction with Varieties should be calculated after Table IX has been constructed. For this, the deviations for each variety from their respective blocks, as shown in Table II, are added taking into consideration their algebraical signs, *i.e.*, the figure in the table against Variety A and Block 3 was arrived at by adding the deviations for that Block against Variety A for the six harvests; *i.e.*, −7.5, −17.0, −3.0, 6.0, −5.0, −2.5 were summed to give −29.0. The totals for Blocks and for Varieties are then made and the Sums of Squares for Blocks and their interaction with Varieties calculated as described in the next two paragraphs.

Table IX.—Blocks and Varieties.

Blocks.	Varieties.				Block Totals.
	A.	B.	. . .	M.	
1 ...	− 34.0	− 75.0	. . .	52.5	−41.0
2 ...	− 24.5	− 72.0	. . .	29.5	−0.5
3 ...	− 29.0	− 67.0	. . .	46.0	−0.5
4 ...	− 17.0	− 75.0	. . .	60.0	122.0
5 ...	−	− 78.0	. . .	51.5	44.0
Variety Totals ...	−104.5	−367.0	. . .	239.5	124.0

The S.S. for the variation between Blocks will be found by squaring the Block totals −41.0, . . . 44.0, adding, dividing by 78 and subtracting the general correction 39.4256 (this being found similarly to that used for the S.S. for Varieties), the result being 197.7731.

The S.S. for the first order interaction between Blocks and Varieties may be found by squaring the figures in Table IX opposite each variety and block, adding, dividing by 6, and subtracting the general correction and also the S.S. due to Blocks and that for Varieties, as follows:

square −34.0 . . . 52.5; −24.5 . . . 29.5; −29.0 . . . 46.0; −17.0 . . . 60.0 and 0 . . . 51.5; from Table IX,

add to give 81,881.00; divide by 6 to give 13,646.8333; subtract 39.4256 (Correction), to give 13,607.4077 and subtract 197.7731 (Blocks S.S.) and 12,297.1744 (Treatments S.S.) to give 1,112.4602, which is the S.S. for the interaction.

In attempting to arrive at the S.S. for the two first order interactions, Blocks × Localities and Blocks × Seasons, it is necessary to collect the figures in Table X from Table II,

Table X.—Blocks × Localities × Seasons.

Locality.	Season.	Blocks. 1	2	3	4	5	Total.
Pusa	1931-32	76.0	44.0	−53.5	−74.5	−53.0	−61.0
	1932-33	30.5	1.0	8.0	45.0	39.0	123.5
	1933-34	−50.0	15.5	14.5	56.5	−16.0	20.5
	Total ...	56.5	60.5	−31.0	27.0	−30.0	83.0
Karnal	1931-32	44.5	35.0	−14.0	5.5	−38.5	32.5
	1932-33	−70.0	−16.0	51.5	50.5	1.0	17.0
	1933-34	−72.0	−80.0	− 7.0	39.0	111.5	− 8.5
	Total ...	−97.5	−61.0	30.5	95.0	74.0	41.0
Grand Total ...		−41.0	− 0.5	− 0.5	122.0	44.0	124.0

The S.S. for the interaction between Blocks and Localities is found by using the locality totals for each block in Table X and proceeding as follows:

square 56.5 . . . −30.0; − 97.5 . . . 74.0; and add to give 38,101.00; divide by 39 to give 976.9487, then subtract 43.9487 (correction for effect of Localities and varying assumed means previously mentioned) and 197.7731 (S.S. for Blocks), leaving 735.2269 as the S.S. for the interaction between Blocks and Localities.

To compute the S.S. for the interaction between Blocks and Seasons, Table XI has to be collated from Table X.

Table XI.—Blocks × Seasons.

Seasons.	Blocks. 1	2	3	4	5	Total.
1931-32	120.5	79.0	−67.5	−69.0	−91.5	−28.5
1932-33	−39.5	−15.0	59.5	95.5	40.0	140.5
1933-34	−122.0	−64.5	7.5	95.5	95.5	12.0
Total	−41.0	− 0.5	− 0.5	122.0	44.0	124.0

The figure 120.5 opposite the 1931-32 Season and Block 1 in Table XI was arrived at by adding the figures in Table X for that Season and Block from both localities, *i.e.*, 76.0 plus 44.5. The other figures in the table were obtained in a similar manner.

The S.S. for the first order interaction between Blocks and Seasons will be obtained by squaring the figures 120.5 . . . −91.5, −39.5 . . . 40.0, −122.0 . . . 95.5, from Table XI, adding to give 91,837.50, dividing by 26 to give 3,532.2115 and subtracting 159.2038 (the correction for the effect of Seasons and the use of varying assumed means which were used already to correct the interaction between Varieties and Seasons) and the S.S. for Blocks, 197.7731, leaving 3,175.2346 due to the interaction.

The S. S. for the second order interaction between Localities, Seasons and Blocks is found by squaring the figures 76.0 . . . −53.0; 30.5 . . . 39.0; −50.0 . . . −16.0; 44.5 . . . −38.5; −70.0 . . . 1.0; −72.0 . . . 111.5; in Table X, adding their results and dividing by 13 to give 5,441.0000, then subtracting 320.1692 (the correction for the effect of Localities, Seasons and Localities × Seasons which was used and explained in collating the Total S. S.), 197.7731 (the S.S. due to Blocks), 3,175.2346 (the S. S. for the interaction Blocks × Seasons) and 735.2269 (the S. S. for the interaction Blocks × Localities), leaving the remaining 1,012.5962 as the S. S. for the second order interaction above mentioned.

The S. S. due to the second order interaction between Localities, Seasons and Varieties is collated by taking the variety totals for each Season within each Locality as found in Table II, squaring them, adding the squares and dividing the total by 5, and then subtracting the correction for the effect of Localities, Seasons, and Seasons × Localities, and also the S. S. for Varieties, Varieties × Localities, and Varieties × Seasons; *i.e.*, square the figures −22.5 . . .11.0; −55.0 . . . 61.0; −23.5 . . . 59.0; 21.5 . . . −7.0; −32.0 . . . 72.5; 7.0 . . . 43.0; add to obtain 104,470.00

and divide by 5 to get 20,894.0000; subtract 320.1692 (the correction for the effect of Seasons, Localities and Seasons × Localities, as used in correcting the S. S. for the interaction Localities × Seasons × Blocks in the preceding paragraph), 12,297.1744 (S. S. for Varieties), 1,314.1769 (S. S. for Varieties × Localities) and 3,839.0218 (S. S. for Varieties × Seasons), leaving the figure 3,123.4577 as the S. S. for the interaction.

For calculating the S. S. for the second order interaction Localities × Blocks × Varieties, Table XII is needed. The figures in this table were obtained by summing those in Table II for each Variety within their respective Block and Locality; *e.g.*, the figure opposite Variety A in Block 1 and Pusa Locality was found by adding the figures −3.5, −7.5 and −14.5 from Table II and so on for the others.

The S. S. for the second order interaction Localities × Blocks × Varieties will be obtained by squaring the figures −25.5 . . . 41.0; −9.5 . . . 18.0; −27.5 . . . 20.5; −22.5 . . . 29.0; −16.0 . . . 22.5; −8.5 . . . 11.5; −15.0 . . . 11.5; −1.5 . . . 25.5; 5.5 . . . 31.0; 16.0 . . . 29.0; from Table XII, adding their squares and dividing by 3 to get 16,598.0000; then subtracting 43.9487 (the correction for the effect of Localities, this being used previously to arrive at the S.S. for the interaction Blocks × Localities), 197.7731 (S. S. for Blocks), 12,297.1744 (S. S. for Varieties), 735.2269 (S. S. for Blocks × Localities), 1,314.1769 (S. S. for Varieties × Localities) and 1,112.4602 (S. S. for Blocks × Varieties), leaving 897.2398 as the S. S. due to the interaction.

Table XII.—Localities × Blocks × Varieties.

Locality.	Block.	Varieties. A.	B.	. . .	M.	Total.	Locality Totals.
Pusa	1	−25.5	−36.5	. . .	41.0	56.5	
	2	− 9.5	−35.5	. . .	18.0	60.5	
	3	−27.5	−35.5	. . .	20.5	−31.0	
	4	−22.5	−36.5	. . .	29.0	27.0	
	5	−16.0	−46.0	. . .	22.5	−30.0	83.0
Karnal	1	− 8.5	−38.5	. . .	11.5	−97.5	
	2	−15.0	−36.5	. . .	11.5	−61.0	
	3	− 1.5	−31.5	. . .	25.5	30.5	
	4	5.5	−38.5	. . .	31.0	95.0	
	5	16.0	−32.0	. . .	29.0	74.0	41.0
Variety Totals ...		−104.5	−367.0	. . .	239.5	—	124.0

Table XIII.—Seasons × Blocks × Varieties.

Seasons.	Blocks.	Varieties. A.	B.	. . .	M.	Total.	Season. Total.
1931-32	1	4.0	− 3.0	. . .	14.0	120.5	
	2	5.5	− 1.5	. . .	−13.0	79.0	
	3	− 1.5	−17.0	. . .	− 1.5	−67.5	
	4	− 7.0	−26.5	. . .	9.0	−69.0	
	5	− 2.0	−17.0	. . .	− 4.5	−91.5	−28.5
1932-33	1	−21.5	−35.5	. . .	26.0	−39.5	
	2	−20.5	−38.5	. . .	29.0	−15.0	
	3	−22.0	−28.0	. . .	28.5	59.5	
	4	−15.5	−24.0	. . .	18.5	95.5	
	5	− 7.5	−36.5	. . .	31.5	40.0	140.5
1933-34	1	−16.5	−36.5	. . .	12.5	−122.0	
	2	− 9.5	−32.0	. . .	13.5	−64.5	
	3	− 5.5	−22.0	. . .	19.0	7.5	
	4	5.5	−24.5	. . .	32.5	95.5	
	5	9.5	−24.5	. . .	24.5	95.5	12.0
Variety Totals ...		−104.5	−367.0	. . .	239.5	—	124.0

For arriving at the S. S. for the second order interaction Seasons × Blocks × Varieties Table XIII is needed. The figures are obtained by summing those from Table II for each Variety within its respective Blocks and Seasons; *e.g.*, to arrive at the figure opposite Variety B in Block 3 and the 1931-32 Season, the figures opposite the same Variety, Block and Season for the two Localities in Table II were added, *i.e.*, −7.0 plus −10.0 giving −17.0.

To obtain the S. S. for the second order interaction Seasons × Blocks × Varieties the figures 4.0 . . . 14.0; 5.5 . . . −13.0; −1.5 . . . −1.5; −7.0 . . . 9.0; −2.0 . . . −4.5; −21.5 . . . 26.0; −20.5 . . . 29.0; −22.0 . . . 28.5; −15.5 . . . 18.5; −7.5 . . . 31.5; −16.5 . . . 12.5; −9.5 . . . 13.5; −5.5 . . . 19.0; 5.5 . . . 32.5; 9.5 . . . 24.5 from Table XIII are squared, totalled and divided by 2 to give 23,022.0000; the figures 159.2038 (correction for the effect of Seasons which was used in arriving at the S.S. for the interaction Blocks × Seasons), 12,297.1744 (S. S. for Varieties), 3,839.0218 (S. S. for Varieties × Seasons), 3,175.2346 (S. S. for Blocks × Seasons), 1,112.4602 (S. S. for Blocks × Varieties) and 197.7731 (S.S. for Blocks) then subtracted to give 2,241.1321 as the S.S. for the interaction.

The Error S. S. for the combined analysis is obtained by finding the difference between the Total S. S. and the sum of the other Sums of Squares that have been determined, as shown in Table XIV.

Table XIV.—Analysis of the Combined Results obtained at Pusa and Karnal during the Seasons 1931-32, 1932-33 and 1933-34.

Variance due to. :—	Degrees of Freedom.	Sums of Squares.
Blocks	4	197.7731
Localities	1	345.3564
Seasons	2	14,475.2782
Varieties	12	12,297.1744
*Blocks × Localities....	4	735.2269
*Blocks × Seasons ...	8	3,175.2346
Blocks × Varieties ...	48	1,112.4602
Seasons × Localities...	2	5,945.6090
*Varieties × Seasons ...	24	3,839.0218
*Varieties × Localities	12	1,314.1769
*Localities × Seasons × Varieties	24	3,123.4577
*Localities × Seasons × Blocks	8	1,012.5962
*Localities × Blocks × Varieties ...	48	897.2398
*Seasons × Blocks × Varieties ...	96	2,241.1321
*Error (Blocks × Localities × Seasons × Varieties) ...	96	1,969.3371
*Total ...	389	52,681.0744

* *Previously explained.*

Table XV gives the Sums of Squares for the individual harvests at Pusa and Karnal during the Seasons 1931-32, 1932-33 and 1933-34.

Table XV.—Individual Analyses of the various Harvests at Pusa and Karnal.

Variance due to :—	Degrees of Freedom.	Sums of Squares for the Seasons.		
		1931-32.	**1932-33.**	**1933-34.**
		Pusa.		
Varieties	12	2,159.8538	6,154.7000	4,498.1846
Blocks	4	1,399.1769	114.6769	485.7461
Error	48	989.2231	1,374.7231	697.3539
Total	64	4,548.2538	7,644.1000	5,681.2846
		Karnal.		
Varieties	12	1,363.9000	5,228.1538	1,169.0385
Blocks	4	361.7308	792.4384	1,967.0616
Error	48	1,654.3692	882.9616	621.5384
Total	64	3,380.0000	6,903.5538	3,757.6385

It is interesting to note that the S.S. due to the interactions Blocks × Varieties, Localities × Blocks × Varieties, Seasons × Blocks × Varieties and Error (Localities × Seasons × Blocks × Varieties), from the combined analysis shown in Table XIV, when summed, agrees with the total of the S.S. for Error from the individual results.

The S.S. due to Varieties for the individual harvests total 20,573.8307, a figure identical with the total of the S.S. for Varieties, Varieties × Seasons, Varieties × Localities and Localities × Seasons × Varieties from the combined analysis.

The total S.S. for Blocks from individual harvests also agree with the total of the S.S. for Blocks, Blocks × Localities, Blocks × Seasons and Localities × Seasons × Blocks from the combined analysis.

The Total S.S. for the individual harvests when summed are equal to the Total S.S. for the combined analysis minus the S.S. for Localities, Seasons, and Localities × Seasons.

Summary.

It is known that the use of an ' assumed mean ' will greatly lessen the labour of carrying out the statistical analysis of data from complicated experiments. Where, however, data from several such experiments are to be combined, the average yields of the trials may vary considerably even though the general trend of the results be the same. In such circumstances, the use of a single assumed mean for all the trials will not be of much assistance since deviations from it will, in many instances, be wide.

This paper describes, with detailed examples, methods for combining the results of several experiments when a different and appropriate ' assumed mean ' is used for each.

Acknowledgments.

Grateful thanks are expressed to Mr. C. Holman B. Williams, Sugar Agronomist and Plant Breeder of the Department of Agriculture, British Guiana, and Mr. R. R. Follett-Smith, formerly Chemist of the Department of Agriculture, British Guiana, for reading this article and making several very helpful suggestions.

References.

Fisher, R. A., and Wishart, J. (1930).—The Arrangement of Field Experiments and the Statistical Reduction of the Results. *Imp. Bur. of Soil Sc. Tech. Com.* No. 10.

Love, H. H. (1936).—Application of Statistical Methods to Agricultural Research.

Paterson, D. D. (1933).—Experimentation and Applied Statistics for the Practical Agriculturist. *Tropical Agriculture.* No. 10.

Shaw, F. J. F. (1936).—A Handbook of Statistics for use in Plant Breeding and Agricultural Problems.

THE PIGMENT OF CACAO BEAN.

The kernel of the cacao bean may be white (pure Criollo variety), purple (Forastero variety) or various intermediate shades (mixed breeds). It has recently been found by Professor R. Robinson that the purple pigment is an anthocyanin which confirms a suggestion put forward independently by Dr. H. Fincke and Dr. A. W. Knapp. The brown colour of the fermented bean would appear to be largely due to chemical changes which take place in the colourless tannin and catechin present in the fresh bean. In the Forastero bean, the anthocyanin also is changed to a brown substance, although in a section of the bean it appears that a little of the pigment remains unchanged.

Now that the anthocyanin has been identified as cyanidin-3-glycoside, the sugar being either glucose on galactose, it is possible to suggest causes for the observed colour changes. After two or three days' fermentation, the purple substance is rendered acid by the citric and acetic acids present in the pulp, and hence in the early stages the citrate or acetate of the anthocyanin is doubtless formed. It is probable that later, at the higher temperatures of fermenting and drying, the anthocyanin is hydrolysed to yield the cyanidin and free sugar. There is also a concomitant change in the colourless catechin and tannin which are partly oxidised by enzymes to red-brown substances.

Dr. H. Fincke has proposed that the unchanged pigment should be called *cacao-red* in accordance with the name given to it by earlier workers, but this name probably arose because, when sections of the beans were examined in Europe, they were completely changed from their original condition. The early experimenters (and, indeed, many of the late ones) did not understand that the purple cacao pigment was one of the original components, and thought that all the colours were produced by the oxidation or condensation of the tannins during preparation for the market. In fact, a good deal of confusion has arisen over the term " cacao red ". It has been used by several writers as the name of a product which was supposed to be formed by the oxidation of a hypothetical glucoside called " cacaonine ". Other writers have used the term in various senses. In view of this confusion, and of the fact that it is *purple* in colour as it occurs in the beans on the tree, it is now proposed that it should be called *cacao purple.*

(" What shall we call the natural unchanged pigment of the Cacao Bean ? "—A. W. Knapp.—*Bulletin Officiel de l'Office International du Cacao et du Chocolat*, 1938, VIII, 6, pp. 209-215.)

The Editor requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

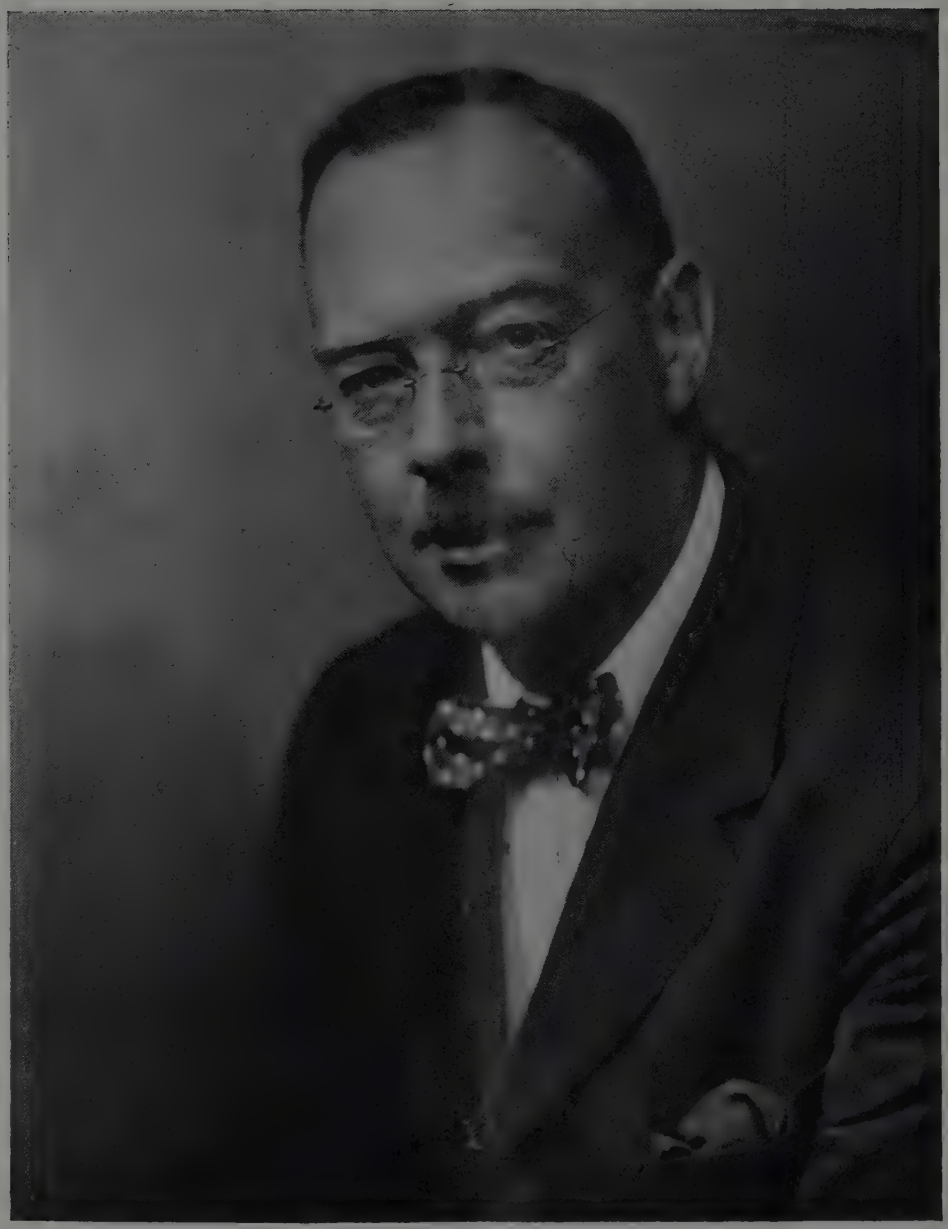

Photo by *Debenham & Gould.*

PROFESSOR R. CECIL WOOD, M.A.

MR. O. T. FAULKNER, C.M.G.

Mr. Odin Tom Faulkner who has been appointed Principal of the Imperial College of Tropical Agriculture in succession to Sir Geoffrey Evans will take up his new duties in Trinidad on or about November 17th.

Mr. Faulkner was educated at St. Albans and Caius College, Cambridge, where he held a scholarship and took the degree of B.A. with first class honours in the Natural Science Tripos, 1911. In the following year he took the Diploma of Agriculture and was appointed Mycologist and Agricultural Expert to the Rubber Growers' Research Association in Malaya. After holding that appointment for two years he joined in 1914, the Indian Agricultural Service as Deputy Director of Agriculture to the Government of the Punjab. In 1921 he resigned from this service to take up the appointment of Director of Agriculture, Nigeria. For his valuable work in this capacity where he defined the agricultural policy of the country and built up a most efficient Department, he was made C.M.G. in 1928. In 1936 he was appointed Director of Agriculture, Straits Settlements and Adviser on Agriculture to the Federated Malay States.

AN APPRECIATION—PROFESSOR R. CECIL WOOD, M.A.

I first met Cecil Wood at Cambridge in 1904. He was Assistant to the Professor of Agriculture at the newly formed School of Agriculture. The occasion was a meeting of the Cambridge University Agricultural Society of which he happened to be the Honorary Secretary. Somebody read a paper, and at the end of the proceedings, light refreshments were served and I am not sure that I did not sing a duet with Wood, a performance that, *mirabile dictu*, does not seem to have unduly deterred the other members.

Wood entered the Indian Agricultural Service shortly afterwards and after serving as a supernumerary at Pusa for a few months, was posted as Deputy Director of Agriculture to the Madras Presidency. After holding this position for two or three years, he was transferred to Coimbatore, where an Agricultural College for the Presidency was in process of formation. Here he stayed for eleven years where he obviously found scope for his great enthusiasm and energy. From modest beginnings this College made rapid progress, and by the time he left in 1922, it had established a reputation second to none in India. I visited Coimbatore on two occasions to hold examinations and it was obvious that the Institution owed a great deal to his personal care and attention. He acted as Director of Agriculture in Madras on two separate occasions, and when he joined the staff of the Empire Cotton Growing Corporation in Tanganyika in 1922, it must have been with many regrets, as he had left a big reputation behind him. After two years as Cotton Specialist at Morogoro, he was transferred to Swaziland in a similar capacity, and his African experience in these two countries proved invaluable later on.

In 1927, a vacancy occurred on the staff of the Imperial College of Tropical Agriculture and when a cable arrived suggesting his name I was truly delighted. As the late Sir James Currie used often to remark "Wood was a born Professor of Agriculture". So he duly arrived in Trinidad in October 1927 and his work at the College has been signally successful. His energy was only equalled by his enthusiasm, and he had the great gift of gaining the confidence of his students and of infecting them with some of his admirable qualities. The affection and respect with which he was regarded is indicated by the number of letters constantly received from past students now serving in all parts of the Empire.

Wood took the greatest trouble with his lectures and was equally good at field classes. He has a great love for the land and took the greatest pride in the College Farm, and it is largely due to his efforts that the many improvements that have been effected were put through. His real love was for peasant as contrasted with estate agriculture and this was a valuable asset in the work of training men for work in those colonies where estate agriculture is non-existent. He found time to produce two publications on tropical agriculture one "A Note Book of Tropical Agriculture" and the other "Cattle in the Tropics", both of which have been in considerable demand as works of reference.

In many ways Wood is still a boy and his capacity for enjoying life and for bringing enjoyment into other peoples lives remains undiminished. Socially, he is a great asset wherever he goes, and all those who have passed through the College during the last eleven years will always remember the delightful hospitality and kindness of Miss Wood and himself. He is no mean artist and among other things he designed the cover of the College Journal "Tropical Agriculture". He carries nothing but the best wishes in his retirement from all who have been associated with him.

G. E.

DETERMINATION OF CATALASE RATIO AS A RAPID METHOD OF SEED TESTING.

By B. N. Singh, P. B. Mathur and M. L. Mehta.
(*Institute of Agric. Res. Benares Hindu University, India*).

Rapid methods of seed testing are doubtless of considerable value both to the seed dealer as well as to the consumer, for a complete germination test occupies a fairly long time which is often inconvenient. Dobrohotov (3) soaked his seeds in a dinitrobenzol solution at 10-15°C. for 5-10 hours or at 45°C. for about an hour and then placed them in a weak ammonia solution (4-5 drops for 15-20 ml.) for 10-15 minutes. The tips containing the embryos were then sliced in order to dissect the primary and lateral rootlets and examined under a lens. The living embryos stained violet-purple while dead tissues were unstained. Dobrohotov claims that the method is reliable for rapid determination of germination capacity of seeds.

Numerous workers have advocated the use of catalase activity as a measure of seed viability. Nemec and Duchon (4) found a positive correlation between catalase activity of dry seeds and their germination capacities. Davis (2), however, failed to get a correlation between the absolute figures expressing catalase activity and the germination percentage of seeds, but introduced the refinement of using the ratio of the catalase activity of the preparation obtained from soaked seeds to the enzymic activity of the one obtained from dry seeds as a fairly reliable index of germination capacity. Baldwin (1) made some catalase determinations on the seeds of several coniferous trees, tests being made of dry seeds and those stimulated by a few days' incubation in the Jacobson germinator. In most cases seeds of high viability, as shown by germination tests made at the same time, showed marked increase in the catalase activity due to stimulation by soaking.

In the course of investigations of the catalase activity of seeds of some crop plants it was observed that the catalase activity of dry seeds was low and gradually increased with an increase in the duration of time of soaking. This recalled to mind the findings of Davis (2) on the enzymic activity of seeds and led to the designing of certain experiments on the relation between the catalase ratio* and the viability of seeds. To test the possibility of using the catalase ratio as a measure of seed viability parallel determinations of catalase ratio and percentage germination were made on comparable lots of seeds drawn from the same sample. The seeds used in this investigation were obtained from several stores and were several years old in certain cases. In order to obtain samples of seeds of various degrees of viability it was occasionally necessary to ask for material that was improperly stored, to have representative samples of seeds of low viability. A given sample of seed was divided into two lots, one lot being used for the determination of catalase ratio while the other was employed for germination tests.

For the computation of catalase ratio the enzymic activity of dry as well as soaked seeds was determined. A quantity of seed (10-12 gm.) was soaked in water which was gradually heated to 55°C. and maintained at that temperature for 45-60 minutes. Soaked as well as dry seeds were macerated in small porcelain mortars, well washed sand being used in the grinding to pulverise the material thoroughly. The pulverising process was usually limited to 2-3 minutes, since grinding without timing gave catalase preparations that varied considerably in their H_2O_2 reducing power. The volume of oxygen liberated from H_2O_2—by a given catalase preparation was adopted as an index of the degree of the activity of the enzyme. Catalase ratio, therefore, becomes the ratio of the volume of oxygen liberated from H_2O_2 by the catalase preparation obtained from soaked seeds to that liberated by the sample prepared from dry seeds. For the simultaneous determination of the oxygen evolutions from preparations obtained from soaked as well as dry seeds the comparative manometer described by Singh and Mathur (5) was employed. As the ratio was required and not the actual amount of oxygen liberated from H_2O_2 the ratio of the manometric lengths only was calculated. Four ml. of catalase extract obtained from soaked seeds was transferred to the side-tube of the right-hand flask of the Singh and Mathur's manometer and the side-tube of the left-hand vessel of the manometer received an equal volume of catalase extract obtained from dry seeds. To the side-tube of each flask was also added 0.4 ml. M/15 Ca (H_2PO_4) $2.H_2O$ followed by 0.6 ml. M/15 Na_2HPO_4 $.2H_2O$. Five ml. of 30 per cent. H_2O_2 were pipetted into the main portion of each of the two vessels. The reaction flasks were then attached to the apparatus and secured by rubber bands. Further details of manipulation have already been described (5). For the determination of germination capacity seeds were first soaked in water for 36-48 hours and then sown in earthenware dishes over moist sand. The percentage of viable seeds was determined after the maximum number of seeds had germinated.

Data showing the relation between catalase ratios and germination capacities of *Zea mays*, *Pisum arvense*, *Cajanus indicus*, *Pisum sativum*, *Triticum vulgare* and *Cicer arietinum* are recorded in Table I and Fig. 1. The data indicates that generally speaking there is a fairly high positive

* Catalase ratio is defined as the ratio of catalase activity of soaked seeds to that of dry seeds.

Table I.

RELATION BETWEEN CATALASE RATIOS AND GERMINATION CAPACITIES OF VARIOUS SEEDS.

Zea mays.		*Pisum arvense.*		*Cajanus indicus.*		*Pisum sativum.*		*Triticum vulgare.*		*Cicer arietinum.*	
Catalase ratio.	Germ. %	Catalase ratio.	Germ. %	Catalase ratio.	Germ. %	Catalase ratio.	Germ. %	Catalase ratio.	Germ. %	Catalase ratio.	Germ. %
0.5	15	2.9	89	3.1	97	1.5	50	1.7	50	1.9	91
0.6	21	2.7	81	2.9	95	1.2	49	2.4	73	2.0	97
0.9	37	2.6	75	2.7	90	1.7	39	1.6	52	1.2	60
1.2	40	1.7	58	0.9	30	0.2	8	0.5	19	1.0	72
1.7	60	1.9	59	0.8	21	0.7	18	1.4	46	0.9	49
2.0	63	0.2	9	0.6	19	0.9	19	1.2	38	0.7	29
0.5	20	0.9	19	0.2	5	1.2	35	2.0	60	0.2	5
3.0	81	0.8	18	1.7	59	1.9	70	1.0	32	0.7	39
2.9	69	0.7	32	1.8	62	1.8	73	1.7	50	0.9	50
2.3	61	0.6	17	1.9	72	2.2	84	0.3	12	0.8	49
0.7	30	0.7	14	1.2	51	2.7	89	0.2	9	0.9	57
0.1	5	0.8	15	1.3	52	2.0	75	2.7	89	1.0	60
0.2	7	0.7	10	1.3	47	2.8	79	0.7	26	1.7	70
0.7	29	0.9	32	1.9	72	2.1	72	1.9	59	1.9	84
0.9	37	0.2	5	1.7	62	2.3	82	0.2	21	1.2	57
0.8	21	0.8	17	2.7	81	2.7	99	1.1	53	1.7	69

correlation between catalase ratios and germination percentages. A catalase ratio greater than unity is associated with seeds of a high degree of viability and low values of the ratio indicate seeds of a poor germination capacity. Moreover, the greater the value of the catalase ratio the higher is the degree of viability of the seeds. In other words, as germination proceeds there is an increase in catalase activity and the extent of this increase is a measure of the vigour of the seedling. The value of the catalase ratio corresponding to a given germination capacity varies with the crop plant under consideration, for example, a catalase ratio of 2 corresponds to 97 per cent. germination in *Cicer* and only 60 per cent. germination in *Triticum*.

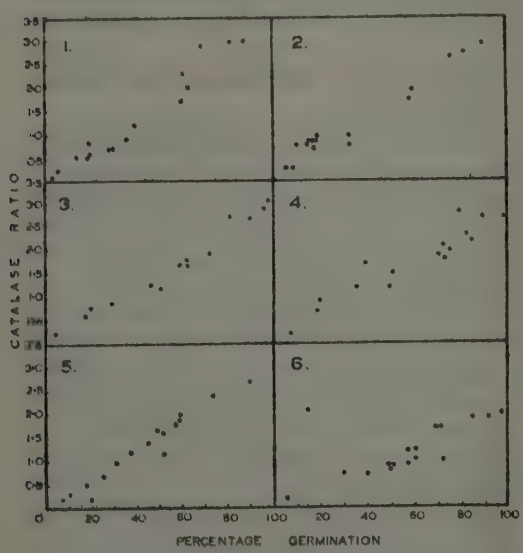

FIG. 1.—RELATION BETWEEN CATALASE RATIOS AND GERMINATION CAPACITIES

1 ZEA MAYS 3 CATANUS INDICUS 6 TRITICUM VULGARE
2 PISUM ARVENSE 4 PISUM SATIVUM 5 CICER ARIETINUM.

References.

1. Baldwin, H. I.—Catalase activity as a measure of viability of tree seeds. *Amer. Jr. Bot.* 22, 635, 1935.
2. Davis, W. E.—The use of catalase as a means of determining the viability of seeds. *Proc.* 18th *Ann. Meeting Assoc. Official Seed Analysts of North America*, 1925.
3. Dobrohotov, V. N.—Rapid determination of germination capacity of seeds. *Selek. Semenovod.* No. 5, 56, 1936.
4. Nemec, A. and Duchon, F.—Sur une méthode indicatrice permettant d'évaluer la vitalité des semences par voie biochimique. *Compt. Rend. Acad. Sci.* Paris, 174, 632, 1922.
5. Singh, B. N. and Mathur, P. B.—A manometer for comparative study of physiological processes. *Biochem. Jour.*, 30, 323, 1936.

Dr. C. W. Wardlaw's series of articles on the Storage and Transport of Tropical Fruits and Vegetables which was published in Vol. XIV, Nos. 3-12, 1937 of *Tropical Agriculture* is now published in the form of a reprint [price 4*s.* 0*d.* (British) and 4*s.* 6*d.* (foreign) post free] which may be obtained from the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Absorption of Mineral Nutrients by Cane at Successive Stages of Growth.—*Arthur Ayres.*

Abnormal or subnormal growth of cane may be due to pathological conditions, or to unbalanced nutrition. As regards the latter condition, information is sometimes sought by analyzing the cane to ascertain the relative proportions and amounts of the different nutrients. Such analyses, however, have little significance unless compared with analyses of cane grown under conditions where the nutrients in the soil are known to be in balance; or, if this is not ascertained, the reference cane should be grown in a soil which is thought to be normal.

The author, therefore, selected a field of H.109 first ratoons, which was supplied with nutrients in amounts generally considered adequate for a satisfactory crop. Representative stalks were analyzed at monthly intervals for 14 months. It was found (in agreement with many prior researches) that the percentage compositions of the leaves and stalks of the sugar-cane are markedly influenced by the age of the plant, particularly during the early months of growth. Hence, analytical data may be of little significance for comparative purposes unless the age of the cane is taken into consideration.

It was further found (also in agreement with previous knowledge) that the principal nutrients are taken up in widely different amounts; potassium and silicon were taken up to a greater extent than nitrogen and phosphorus, and calcium and magnesium in the least amounts. In all cases except that of silicon, maximum rates of absorption were attained at the age of three months, although some nutrients, as nitrogen, were absorbed at a seemingly faster rate than others. After the maximum rate was passed, the rates of absorption of all nutrients decreased. All this goes to show that absorption of nutrients by the cane is not primarily a function of the rate of growth, but of the age or state or development of the cane.—(*Inter. Sugar Jl.*, Vol. XL, No. 475, pp. 279-280, 1938.)

* * *

Absorption of Plant Food by Cane.—*By B. E. Beater and J. L. Du Toil.*

A study was made of the plant-food uptake of eight Coimbatore canes on fertilized and unfertilized soils. None of these eight varieties showed any significant difference in their mineral compositions, except that Co. 301 was noticeably lower in calcium in the stalks. A very high accumulation of potash is noted in the tops of all varieties. Magnesium is well distributed throughout the plant, but is more abundant in the stalks and juice; roughly 40 per cent. of the ash of the juice is composed of potash and magnesium, and the same can be said of the tops. Heavy applications of nitrogenous fertilizer increase the amounts of nitrogen in all parts of the cane.

From a consideration of their results the authors reach the important conclusion that more than all the fertilizer added to a crop of cane (with the exception of the superphosphate) is removed from the field in the stalks. This obviously indicates that South African cane farmers are taking more fertility out of the soil than they are putting back.—(*Facts about Sugar*, Vol. 33, No. 8, p. 34, 1938.)

* * *

Production of Paper Pulp from Bagasse.—*O. Kuhne.*

A bacteriological process has been worked out by E. A. Ritter, of Natal, South Africa, for preparing bagasse for use as pulp for paper production and some results obtained by it are here reported, though details of the actual process are not given. As the result of the fermentation treatment, the lignin, pentosan and wax are lowered, and the cellulose content is increased. Bagasse so treated was pulped with soda and with soda and sulphite in small scale digesters, and the product made into paper using an experimental machine, yields of about 70 per cent. with alkali consumptions of 14 to 16 per cent. being obtained. To produce a good white paper, about 6 per cent. of chlorine was required. It is believed that in view of these high pulp yields, the Ritter process of pre-treatment of bagasse should be tried out on a large scale. It might enable bagasse to compete with wood in the manufacture of paper.—(*Inter. Sugar Jl.*, Vol. XL, No. 475, p. 277, 1938.)

* * *

An Experiment in Reconditioning Mill Brasses.—*By H. Horton.*

For the experiment, two mill brasses 17 inches by 22 inches, which had been worn down about half an inch to five-eights of an inch below their original thickness, were built up to their original dimensions with white metal. The paper describes the methods used to prepare the brasses, the tinning of the brasses, the necessary preparations before casting, and the actual casting. An examination of the finished bearing failed to show, either by analysis or by the microscope, any indication of segregation. The chief engineer at Moreton Central Mill, where the experiment was carried out, reports that these bearings were not water-jacketed, and at the termination of the crushing season no apparent wear had taken place, both bearings being of the original thickness. The author is of the opinion that the old brasses can be successfully salvaged by the use of white metal, and that in new mills it might be worth while considering white metalled cast iron step instead of brasses.—(*Facts about Sugar*, Vol. 33, No. 8, p. 30, 1938.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Non-Toxic Seleniferous Soils.—*By H. W. Lakin, K. T. Williams and H. G. Byers.*

Although seleniferous soils may produce highly toxic vegetation, this is not always so. An examination of a large number of seleniferous soils has confirmed the fact that there is no quantitative relation between the quantity of selenium in the plants and in the soil. The highly seleniferous soils in Hawaii and Puerto Rico showed an apparent absence of all known selenium-loving plants, and in Puerto Rico, where a detailed examination of the vegetation was carried out, the plants contained only 1.0 p.p.m. of selenium, *i.e.* all the factors influencing the lack of quantitative correlation between the selenium content of the soil and the vegetation were inoperative. Absorption of selenium depends then on the character of the soil and the form in which the selenium is present. There are three forms in which the selenium will only become available to the plants by slow processes of hydrolytic action: as free selenium (to be expected where commercial selenium sprays have been used, but a condition not found naturally); as pyritic selenium in immature soils formed from parent material containing pyrites; in mature soils as basic ferric selenite, which provides essentially insoluble selenium. Iron was present both in the Hawaii and Puerto Rico soils. In the latter place, the selenium content of the soil at 12-24 in. depth was over twice that in the top 12 in., and in this lower horizon iron oxide accumulated to form a hard-pan, suggesting the association of selenium with iron oxide. It is thus possible to have highly seleniferous soils which are not dangerous nor even slightly harmful. —(*The Analyst*, Vol. 63, No. 748, p. 522, 1938.)

* * *

Soil Investigations in the Sugar-cane Lands of British Guiana.

Attention has been drawn in the most recent Divisional Reports of the Department of Agriculture of British Guiana to the change which has been effected in the soils of the coastal belt, originally saline alkaline clays, under the influence of drainage, irrigation, tillage and the continued use of sulphate of ammonia. Particulars are given of further determinations, based on samples from the top 6 in. of plots with varied dressings of sulphate of ammonia, showing the effect on the normal and exchange reactions and the theoretical lime requirement.

A large number of correlations between soil characteristics have been worked out from the data obtained from 45 composite soil samples taken during the detailed survey of sugar-cane soils. The most interesting of these is the high negative correlation (−0.990) between the percentages of exchangeable hydrogen and magnesium. The regression equations for magnesium, calcium and sodium on hydrogen are calculated and suggest that, before the entry of hydrogen, the clay complex contained 63.0 per cent. magnesium, 30.1 per cent. calcium, 2.0 per cent. potash and 4.8 per cent. sodium. As hydrogen enters the absorbing complex the rates of outgo of magnesium, calcium and sodium are in the ratio of 12.5 : 4.4 : 1.0. Exchangeable magnesium and sodium will disappear from the complex at approximately the same degree of unsaturation; exchangeable calcium persists and, rather surprisingly, the proportion of exchangeable potash remains unaffected by the degree of unsaturation. It is possible that this potash is more closely identified with the organic rather than the mineral complex.

These correlations between magnesium and calcium with hydrogen have an interesting bearing on the alleged occurrence of magnesium toxicity on certain soils as the result of which it has become the practice on certain estates to apply a small dressing of slaked lime to soils possessing a low ratio of lime to magnesia. From the correlations obtained, soils with a low lime-magnesia ratio will be saline, and therefore likely to support canes showing signs of salt toxicity and such soils possess low lime requirements.—(*Int. Sugar Journ.* Vol. XL, No. 476, p. 297, 1938.)

* * *

Studies on Soil Structure: Some Nitrogen Transformations in Puddled Soils. *J. F. Breazeale and W. T. McGeorge.*

This is a study of the effect of soil structure, together with soil moisture, upon the nitrogen transformations in the alkaline calcareous soils of the semi-arid Southwest United States of America. Alkaline calcareous soils are extremely active nitrifiers and ammonifiers. On creating a puddled condition in these soil-types, nitrification is completely stopped and denitrification becomes active. Ammonium sulphate is denitrified to a greater extent than sodium nitrate, and this may have a bearing upon the relative value of these two nitrogen fertilizers on poorly-drained soils. There is a greater loss of nitrogen from the puddled soil, regardless of whether it is added as nitrate or ammonium-ion, and this loss is entirely as gaseous nitrogen. Dry fallowing a puddled soil completely restores its nitrifying power. When ammonium salts are added to the soil much of the ammonium-ion is rapidly fixed by the colloids before nitrification. In a well-aerated soil, zeolite ammonium is just as readily nitrified as the sulphate. There is a slower rate, or less nitrification and less denitrification, of the zeolite form of ammonia. The moisture equivalent is also the critical moisture content for microbiological oxidation processes in puddled soils. At this moisture content, nitrification is checked and denitrification becomes active. If the soil is not in a puddled condition, then the critical point is not reached until the moisture content is about 1.4 times the moisture equivalent.—(*Chemical Abstracts*, Vol. XXXII, No. 14, p. 5550, 1938.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.).

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
25th August ..	5	4½	9	0¾
1st September ..	5	5¼	9	2⅛
8th September ..	5	5¼	9	2⅛
15th September ..	5	6	9	4½
22nd September ..	5	6¾	9	3¾
29th September ..	5	9¾	9	4½
6th October ..	5	6	9	0¾
13th October ..	5	6	9	0¾
(14*th October*, 1937) ..	6	6	10	3

During the period under review a heavy trade in refined at steadily advancing prices brought about by the increased gravity of the political situation caused substantial terminal covering and prices for raws at one time advanced by 3¼*d.* per cwt. When the political outlook improved, however, there was a slacking off in refined demand which was followed by little buying interest being shown in actual raws. The tone of the market is thus, once again, fully steady.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows:

	Pence per lb.
31st August	8
7th September	7 15/16
14th September	7 15/16
21st September	8 1/8
28th September	7 7/8
5th October	8 15/16
12th October	8 3/8
(13*th October*, 1937) ..	7 7/8

The market has been dominated by political uncertainty during the past few weeks and little business has been transacted. The decision of the Committee to leave the percentage at 45 for the last quarter of the year was in accordance with the market's expectations but the rise in price which this decision might otherwise have brought about was overruled by general nervousness. News of the motor and tyre trades in America continues optimistic and the figure for American consumption for August was about 6,000 tons better than the previous month.

* * *

LIME PRODUCTS.—Hand pressed is neglected and the nominal value of 30*s.* per lb. is unchanged. There is no demand for Distilled and Stocks are plentiful. *Lime Juice.*—Raw is slow and unchanged at 1/8 to 2/2 according to quality, and there is no demand for concentrated.—(*West India Committee Circular*, 22nd September.)

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American. Mid.	*Egyptian Giza 7.*	*F.G.F. Sakel.*
26th August ..	4.74	7.37	7.72
2nd September ..	4.85	7.40	7.75
9th September ..	4.71	7.32	7.67
16th September ..	4.81	7.52	7.87
23rd September ..	4.76	7.57	7.92
30th September ..	4.83	—	—
7th October ..	5.01	—	—
14th October ..	5.24	—	—
(15*th October*, 1937)	4.82	7.46	7.42

Business has generally been overshadowed by the political situation. Raw cotton prices have not shown much change and the official U.S.A. crop estimate of 11,825,000 bales was rather less than expected. No business is reported in West Indian Sea Island which has been neglected.

* * *

COCOA.—It is generally believed that when the report of the Commission which investigated the West African Cocoa Industry is published it will exercise an important influence on the marketing policy of new crop, since West African producers look to the Government for advice and assistance. However, a reduction in total world production would likely solve the grievances of producers more promptly than interference by Government could. Of late the market has been entirely overshadowed by the political situation, and thus business has been restricted. New Crop Accra is quoted at 24*s.* 3*d.*, and locally the market is nominally quoted at $5.75 per fanega.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COFFEE.—Markets everywhere have been under the influence of the international crisis. The demand for spot coffees in London has been principally confined to cheaper varieties. Quotations per cwt. as follows: London cleaned Costa Rica bold size 49*s.* to 80*s.*; Superior Santos: 32*s.* 6*d.* and freight, No. 7 Rio: 24*s.* Kenya Ordinary: 60-63*s.* Jamaica Ordinary: 40-42*s.*

* * *

COPRA.—The market continues dull and prices show no improvement. West Indian f.m.s. is 2*s.* 6*d.* lower at £10 12*s.* 6*d.* c.i.f. London.

* * *

BANANAS.—Jamaicas are unchanged at £19 15*s.* per ton delivered London and £19 10*s.* delivered nearest Station Provinces. Brazilians are also unchanged at £15 10*s.* delivered London and £16 10*s.* Provinces.

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